

Improving Rural Traffic Safety with Video, Radar and Activated Flashing Beacons

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Late 2012, Missouri DOT moved forward to implement a traffic safety project at the intersection of Pink Hill Road and Route H near Oak Grove, MO. The intersection was located at the top of a steep hill in a rural area. Vehicles crossing Route H at Pink Hill Road or turning from Pink Hill Road onto southbound Route H were unable to clearly see vehicles driving northbound on Route H.

Similarly, vehicles traveling northbound on Route H had limited advance visibility to eastbound vehicles on Pink Hill Road and almost no advance visibility to westbound vehicles on Pink Hill Road. Originally the only warning indication at the crossing was a 24/7 AC span-wire flashing beacon.

A crash at this intersection took out the 24/7 overhead flashing beacon as the vehicles came to rest in the northeast corner of the intersection knocking down a wooden pole supporting the beacons.

Motorists claimed they did not have sufficient site distance when turning onto Route H from Pink Hill Road. Site distance measurements showed insufficient stopping site distance for motorists on Route H northbound

when vehicles turned onto the road from Pink Hill (onto Route H). The intersection overhead flashing beacons were installed in the past to alert motorists of this condition. The intersection was studied again due to the recent crash and citizens' concerns. The following was discovered:

1. There was insufficient stopping site distance for motorists northbound approaching Pink Hill Road on Route H.
2. Motorists facing west on Pink Hill Road could see clearly to the north, but lost sight of a vehicle or could not see a vehicle approaching from the south due to a vertical curve of the road.
3. Motorists facing east on Pink Hill Road could see clearly to the north but lost sight of a vehicle or could not see a vehicle approaching from the south due to a vertical curve in the road. This led motorists to modify their behavior to pull out into the southbound lane when going north until they were up to speed and far enough away from the intersection to merge into the proper lane.

Conventional countermeasures for

these types of problems are:

1. Install traffic control device to assign ROW such as 4-way stop or traffic signal.
2. Cut down the roadbed removing the vertical curve.
3. Install an overhead 24/7 beacon warning device.
4. Install more warning signs.
5. Remove access of the side road.

Measure 1 was inappropriate as traffic signals or a 4-way stop is not warranted. The installation of unwarranted traffic signals can actually increase accidents and warranted 4-way stop conditions tend to be interim conditions until a traffic signal can be installed.

Measure 2 is expensive and may still be in the future plans as funding becomes available.

Measure 3 was not effective.

Measures 4 and 5 are not appropriate.

It was determined an innovative solution was needed. MoDOT wanted to warn northbound approaching motorists of the insufficient stopping site distance ahead at the Pink Hill Road intersection but not use the 24/7

overhead beacon which over time becomes part of the landscape thus an ineffective warning device. At the same time we wanted to provide more information to the motorist east and westbound on Pink Hill Road of vehicles approaching from the south on Route H. This would require an interactive warning.

To deal with the safety issues, MoDOT approached Traffic Control Corporation's (TCC) Missouri office headed by Ken Kohl because of past experience and the variety of equipment TCC could offer to resolve the situation. One of the key factors required by MoDOT was a non-intrusive solution for detection of vehicles at all key points around the intersection.

It was agreed upon that detection of cars pulling up to the stop bars at Pink Hill Road would be done with the use of an Econolite Autoscope package.

The intersection advance detection of cars traveling northbound on Route H would be done using an RTMS G4 side-fire radar sensor.

The final layout of the warning beacons included an advance warning beacon for northbound traffic on Route H and two warning flashers located at the Pink Hill Road intersection as shown in Figure 1 (shown on next page or for larger view see last page of article).

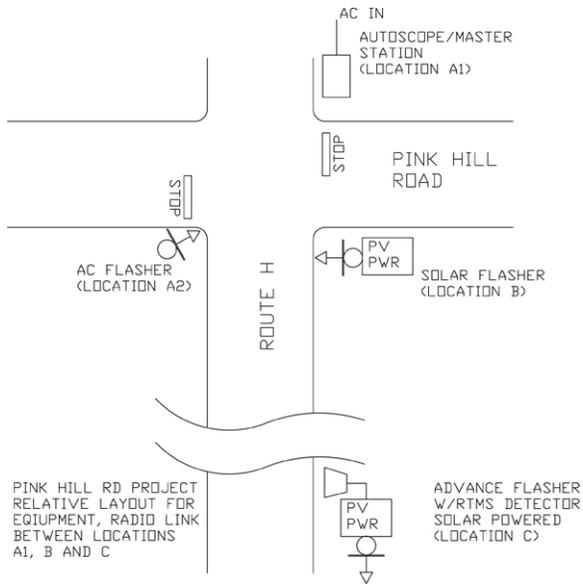


Figure 1 - diagram of Pink Hill Road and Route H warning system with locations of systems (see larger view on last page of article)

When the Autoscope system detects vehicles at the stop bars at Pink Hill Road, it causes transmission of a radio signal to the intersection advance flasher on Route H located down the hill from the intersection. If the intersection advance flasher detects a northbound vehicle on Route H, this triggers the flashing beacons at the Pink Hill Road crossing thus warning drivers of an approaching vehicle they may be unable to see.

The agreed upon design has four points in it. The first is the main control unit which includes an Autoscope Rack Vision Terra 2-channel video processor unit with two cameras, connected to an AC-power feed already at the site. This point is also hardwired to an AC flashing beacon assembly. The second point,

on the other side of the road via the old span-wire supports (Location A1 and A2).

The third point is a solar-powered flashing beacon on the southeast corner of Pink Hill Road and Route H (Location B). Finally, the fourth point in the system is the advance flashing beacon unit to warn northbound traffic on Route H heading up the hill to the intersection. This point also includes an RTMS sensor mounted on the pole to detect northbound vehicles. AC-power is available only at the northeast corner of Pink Hill Road and Route H. Points B and C are solar-powered to keep project costs down. Figure 1 shows a physical layout of the site with all four points labeled.

Once the design was firmed up between MoDOT and TCC, TCC called STC to work out the details for implementation of the equipment. Even though STC's primary focus is on solar-powered systems, it is not uncommon for customers to request AC-based equipment on projects, which STC is more than capable of providing.

In coming up with a design, it is important to apply as much existing and proven equipment as possible. If one analyzes the operation of the system it is similar to a wireless crosswalk application. The key difference in this project is the lamps don't all turn on at once.

Using this approach STC was able to modify the basic system software for the Solar Ped-X wireless crosswalk system to meet the project objectives. The Solar Ped-X system operates on a master-slave relationship between the units in the system and uses "kill switch" timers to ensure all points in the system are always alive and can communicate with the master unit.

This is different than systems which use peer-to-peer communications as these systems can have a point malfunction and not be detected by the other points in the system as any one unit can activate itself or any other units in the system. In Solar Ped-X based systems if one unit faults out, the other points in the system will go into a cyclical fault flash pattern to provide a level of warning to motorists and an alert that the system has malfunctioned. Also, an output can be generated to transmit an alarm over a wireless network if needed.

TCC provided all the necessary Autoscope equipment to STC for integration into the AC-powered system enclosure for the Pink Hill Road intersection. STC incorporated the master control portion of a Solar Ped-X system into the enclosure at location A1 (see Figure 1) which consisted of a Frequency Hopping Spread Spectrum (FHSS) radio, control logic, timing select interface with self-test switch, AC NEMA

flasher. TCC also requested a built in flat screen monitor and outlets be included in the enclosure. Figure 2 is a photo of the finished enclosure installed in the field.



Figure 2 - Master control station with Autoscope equipment at Pink Hill Road

The outputs of the Autoscope unit are used like a button push at a crosswalk to generate a call pending in the control logic. When the call is serviced, the control logic transmits an ON command to the advance slave flasher. This ON command consists of a timing value loaded into the run timing register in the slave control logic. The logic tries to count down the register to zero to turn off the flashing beacon. However, since a car may have to wait to cross the intersection, as long as the Autoscope detects the vehicle, the call remains. This causes the timing logic in the slave to be refreshed with the maximum run time value for the flashing beacon (retriggerable timer).

When the detection occurs at the stop bars at Pink Hill Road, only the advance flashing beacon is activated. Figures 3 and 4 are photos of the advance slave from front and rear.



Figure 3 - Front view of the advance flashing beacon for the Pink Hill Road intersection



Figure 4 - Rear view of the advance flashing beacon for the Pink Hill Road intersection showing the RTMS unit

The advance flashing beacon station, location C, includes an Econolite RTMS G4 unit mounted on the pole to detect vehicles traveling northbound on Route H. The unit is a side-fire radar which produces an open-drain output when it detects a car in the lane it is watching. In this case it has only one lane of northbound traffic to watch.

When a vehicle is detected a call pending is generated in the local logic control. When the master goes through a read cycle on the slaves, the bit is read along with the local com-fault timing value. The call pending is then processed by the master station logic which then sends out an ON command in the form of a run timer value to the solar beacon at location B and turns on the flasher at A2. This provides the necessary warning to motorists at the Pink Hill Road stop bars that a vehicle is approaching in the northbound direction and may not be visible to them.

If multiple vehicles are detected this will continue to generate call pending conditions in the logic on the advance flasher/detector station. As the master unit processes these, it will continue to refresh the run time value for the flashing beacons at the Pink Hill Road intersection. Figure 5 shows the flasher at location B, a standard STC Solar Ped-X warning beacon less pedestrian button, and Figure 6 shows the AC-powered

flasher on the southwest corner of Pink Hill Road which is operated from the master enclosure on the northeast corner of the intersection.



Figure 5 - Solar-powered beacon at Pink Hill Road crossing, southeast corner facing eastbound traffic

Since two points in the system are solar-powered and have different sized solar arrays, it is important to review how to properly design a solar-power system for these types of projects. The three key points of information to properly design are as follows: 1. Location - Defines the solar data to be used for the design of the project; 2. Load - Defines anything which draws power and how much based on mode of operation; 3. Duty Cycle - Defines the average time per day each load will be drawing power.

From these three points a sizing report can be generated to determine the appropriate size of the solar array and the battery bank for the given

project parameters (refer to *IMSA Journal* article at www.solar-traffic-controls.com/pdf_articles/IMSAJulAug2002.pdf).

Attention to details such as the DC LED lamp optical output must be watched when reviewing the loads. This is especially true in light of recent FHWA rulings regarding optical output of solar-powered beacon systems (*IMSA Journal*, July/August 2013 "FHWA: Daytime Dimming of Signals/Beacons Not Acceptable") indicating DC lamps must meet optical standards outlined in section 4D.06 and not be dimmed during daylight hours. To meet these standards precludes the use of all-in-one type flashing beacon units which limit their solar array and battery to meet a package paradigm standard rather than an optical output standard.

The duty cycle for a project like this tends to be one of the great variables as it may be subject to seasonal influences on a route to a recreational area such as a popular lake. For a project such as this the duty cycle will need to be based on the worst case traffic flow estimate and the typical run time of the beacons per activation. The flasher/detector station used an 85W solar array in this case based on data provided which included the 24/7 draw for the RTMS sensor.

The solar flashing beacon at point B

only needed a 65W solar array based on the worst case design parameters given. Both solar-powered systems include a sealed battery bank and solid-state controls with the DPC-2000 integrated charge/flasher control unit. One of the long term issues facing solar power at the site will be for MoDOT to work with property owners at the northbound flasher/detector station (point C in Figure 1) to ensure trees are trimmed back far enough to prevent significant shading of the solar array. An alternative to this is to increase the solar array size to a 140W system thus allowing higher charging rates during the middle of the day when sunlight is available.

Results/Feedback to Date

MoDOT's experience and response to the system since its installation has been great. MoDOT still needs more time to pass as motorists use the system. An 'after' study is planned this year. Early results and comments from the public have been positive. In fact as we observed the system operation after turn on, citizens went out of their way, stopping their cars and thanking us for installing the system. MoDOT has plans to install similar systems at other locations where site distance is less than desirable.



Figure 6 - AC powered beacon at Pink Hill Road crossing, southwest corner facing westbound traffic

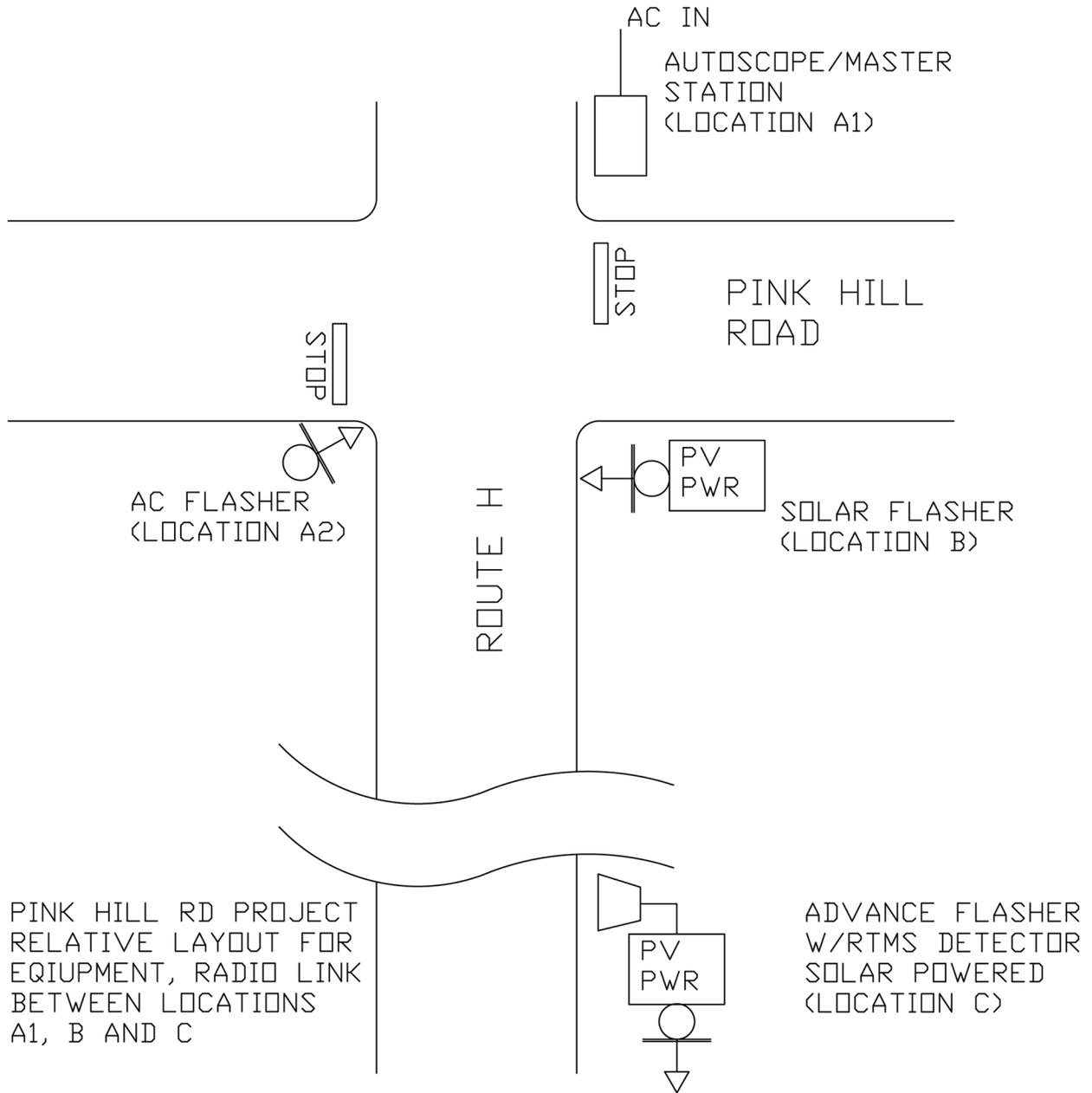


Figure 1- diagram of Pink Hill Road and Route H warning system with locations of systems

For additional information or questions:

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Related links:

STC website: www.solar-traffic-controls.com

STC Solar Ped-X:

www.solar-traffic-controls.com/pdf_datasheets/Wireless_PedX.pdf

Traffic Control Corporation website: www.trafficcontrolcorp.com

Econolite Autoscope: www.econolite.com/Products/terra-tap.aspx
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Econolite RTMS: www.econolite.com/Home/rtms-ad.aspx#G4

For more information on STC's products and services, please stay on this website or go to: www.SolarTrafficControls.com or send an email to: info@SolarTrafficControls.com or call [480.449.0222](tel:480.449.0222).